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# FOREST INSECT AND DISEASE MANAGEMENT / evaluation report

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Effects of Orthene,<sup>®</sup> Sevin 4 Oil<sup>®</sup> and Dylox<sup>®</sup>  
on Aquatic Insects Incidental to Attempts  
to Control Spruce Budworm in Maine, 1976 A/A to

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## INTRODUCTION

The monitoring of aquatic insect populations has accompanied the spraying of chemical insecticides for spruce budworm control in Maine and Canada for many years (Gorham 1961, Dimond *et al.* 1972, Rabeni and Gibbs 1975, Kingsbury 1976). These studies<sup>1</sup> help to assess the environmental effects of a chemical and may influence decisions on the selection of chemicals for use in special areas.

This study evaluated the effects of Orthene® (acephate), Sevin 4 Oil® (carbaryl), and Dylox® (trichlorfon) on the aquatic invertebrates of selected northern Maine streams.<sup>2</sup>

## MATERIALS AND METHODS

Ten brooks were selected for study: one treated with Orthene, three with Sevin 4 Oil, two with Dylox, and four as untreated controls. An attempt was made to select areas that were ecologically comparable with regard to discharge and substrate. Various stretches of the experimental brooks, which were located in several watersheds were exposed to spraying (Table 1).

It was originally planned to locate study streams in 1500-acre blocks used as U. S. Forest Service pilot test plots. Most of these blocks, however, did not contain suitable study streams; only the Orthene-sprayed stream was located in one of these blocks. The two Dylox sprayed streams were located within 1500-acre plots used by the University of Maine, and the three Sevin-sprayed streams were located within Maine Bureau of Forestry spruce budworm control program spray blocks. The latter covered many thousands of acres.

Orthene (75S formulation) was applied at a rate of  $\frac{1}{2}$  lb in  $\frac{1}{2}$  gal of water per acre by a PV2 twin-engine aircraft. Dylox (Dylox 4 formulation) was applied undiluted at a rate of  $\frac{3}{4}$  lb per acre, at a spray-emission rate of 24 fl oz per acre, by a TBM single-engine aircraft. Sevin (Sevin 4 Oil formulation) diluted with kerosene was applied at a rate of  $\frac{3}{4}$  lb per acre, (spray-emission rate of 30 fl oz per acre) by a PV2 aircraft for streams in the Seboeis watershed and a DC4 four-engine aircraft for those in the Fish River watershed. All aircraft were equipped with conventional booms and nozzles.

Each experimental stream was sampled 7 days before spraying and again 2, 30, and 60 days after spraying. On each sampling date, nine square-foot Surber samples and one 24 h square-foot drift sample were collected. Since flow rate varied throughout the sampling season, the volume of water sampled also varied. As this volume was not determined, drift samples were not analyzed statistically. All samples were preserved in ethanol or formaldehyde and returned to the laboratory, where the organisms were separated from the debris by hand sorting.

Aquatic insects in the samples were identified to genus where practical. The mean numbers of taxa and of organisms for each sampling date were compared within each stream, using a one-way analysis of variance and Newman-Kuels multiple-range test. The significance level was set at 0.05.

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<sup>2</sup>Use of trade, firm or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

**Table 1. Brooks monitored during the 1976 pilot control projects for spruce budworm control in Maine.**

Treatment	Brook	Watershed	Town	Approximate Distance Treated(Km)
Unsprayed	Crystal Brook	W. Br. Mattawamkeag River	Mt. Chase Plant.	0
	Sargent Brook	W. Br. Mattawamkeag River	Mt. Chase Plant.	0
	Tracy Brook	Aroostook River	T7R6	0
	Railroad Brook	Fish River	T14R6	1
Orthene	Squapan Inlet	Aroostook River	T11R4	1.8
Sevin 4 Oil	Mosquito Brook Trib.	Fish River	T14R6	2.7
	Unnamed Brook	Seboeis River	T6R7	3.1
	Sawtelle Brook Trib.	Seboeis River	T7R7	2
	Brown Brook	Aroostook River	Ashland	3.5
Dylox	Burpee Brook Trib.	Aroostook River	T13R5	2.0

<sup>1</sup>Light deposit of Sevin 4 Oil spray found at sample site.

<sup>2</sup>No spray deposit found at sample site.

**Table 2. Comparison of the mean numbers of taxa and of organisms per square-foot sample in control and treated brooks.**

Period of Collection	Control				Orthene		Sevin 4 Oil		Dylox	
	Crystal Brook	Sargent Brook	Tracy Brook	Railroad Brook	Squapan Inlet	Mosquito Bk. Trib.	Unnamed Brook	Sawtelle Bk. Trib.	Brown Brook	Burpee Bk. Trib.
MEAN NUMBER OF TAXA PER SQUARE-FOOT SAMPLE										
Prespray	16.2a <sup>1</sup>	16.6a	9.4a	12.7a	10.7a	8.7a	20.3a	10.6a	8.0a	14.0a
Postspray 1	14.9a	9.3b	13.0b	8.1a	14.9ab	4.4b	21.2a	11.4a	6.2a	14.2a
Postspray 2	15.2a	17.7a	14.7b	12.4a	14.7b	7.8a	15.0b	13.9a	10.8b	15.4a
Postspray 3	16.1a	15.8a	15.4b	11.0a	19.7c	9.7a	17.3a	14.0a	14.3c	15.7a
MEAN NUMBER OF ORGANISMS PER SQUARE-FOOT SAMPLE										
Prespray	78.6a	58.3a	45.6a	49.4a	48.6a	33.2a	136.8a	88.0a	21.7a	101.3a
Postspray 1	61.4a	24.7b	76.4a	18.2b	63.0a	7.8b	86.2a	83.8a	22.8a	88.1a
Postspray 2	69.9a	94.0a	167.1b	42.3a	149.4b	19.6a	66.0a	125.3a	25.1a	100.4a
Postspray 3	239.2a	86.7a	133.2b	26.2b	140.2b	37.1a	133.3a	99.8a	42.8a	79.3a

<sup>1</sup>Numbers with letter in common are not significantly different at the 0.05 level.

If changes between sampling dates in any stream were significant, the same statistical analysis was carried out on the number of taxa and organisms of the major insect groups, Trichoptera, Plecoptera, Diptera, and Ephemeroptera, to determine which orders had contributed most to the changes.

## RESULTS

Comparisons of mean numbers of taxa and numbers of organisms per square-foot sample in the ten streams are summarized in Table 2. The results will be discussed by treatment groups.

### Controls

Benthic samples from Crystal Brook showed no significant changes in number of organisms from May to August (Table 2).

Fewer taxa and organisms were collected in the first postspray sample than in any other samples from Sargent Brook. Further analysis demonstrated that this result was attributable to decreases in numbers of taxa of Trichoptera and Plecoptera and to decreases in both numbers of taxa and

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Table 3. Significant changes in mean numbers of taxa and numbers of Trichoptera, Plecoptera, Diptera, and Ephemeroptera in treated and control brooks.

Period of Collection	Trichoptera						Plecoptera						Diptera						Ephemeroptera					
	Control			Orthene			Dylox			Sevin 4 Oil			Control			Orthene			Dylox			Sevin 4 Oil		
	Sargent Brook			Railroad Brook			Squapan Inlet			Mosquito Brook			Tracy Brook			Squapan Inlet			Squapan Inlet			Mosquito Brook		
	1			1			1			1			1			1			1			1		
Prespray	5.22a	2.22a	1.55a	2.22a	1.44a	—	0.55a	1.22a	2.33a	2.22a	2.22a	—	—	—	—	—	—	—	—	—	—	—	—	—
Postspray 1	2.22b	1.66a	2.11a	1.66a	.44b	—	1.11b	1.00a	2.66a	2.66a	2.66a	—	—	—	—	—	—	—	—	—	—	—	—	—
Postspray 2	4.66a	2.77a	2.66a	2.77a	2.44a	—	1.22b	.00b	.00b	2.77a	2.77a	—	—	—	—	—	—	—	—	—	—	—	—	—
Postspray 3	4.55a	4.11b	3.77b	4.11b	2.33a	—	1.22b	.11b	.88c	4.11b	4.11b	—	—	—	—	—	—	—	—	—	—	—	—	—
MEAN NUMBER OF TAXA PER SQUARE-FOOT SAMPLE																								
Prespray	8.22a	18.00a	—	—	—	—	1.33a	4.44	—	—	—	—	13.00a	19.66a	29.77a	7.66a	2.33a	—	—	—	—	—	—	—
Postspray 1	3.66	3.88b	—	—	—	—	5.22b	3.11a	—	—	—	—	4.89a	2.00b	11.77b	11.11a	.11b	—	—	—	—	—	—	—
Postspray 2	20.44b	16.55a	—	—	—	—	.33a	.00b	—	—	—	—	20.33a	8.44bc	28.55a	38.77b	1.11b	—	—	—	—	—	—	—
Postspray 3	14.11b	6.55b	—	—	—	—	.55a	.11b	—	—	—	—	49.33b	19.44ac	10.66b	35.33b	2.55a	—	—	—	—	—	—	—

MEAN NUMBER OF TAXA PER SQUARE-FOOT SAMPLE

<sup>a</sup>No significant change detected.

numbers of individual Ephemeroptera (Table 3). Numbers of taxa and organisms for Sargent Brook had increased to prespray levels by the next sampling period.

From May to August, an increase in standing crop was seen in samples from Tracy Brook (Table 2). The significant differences are attributed to increases in both numbers of taxa and numbers of individual Ephemeroptera (Table 3).

Numbers of organisms per square foot in Railroad Brook were low in June and August (Table 2). Changes were attributed to fluctuations in numbers of Trichoptera (Table 3). The first postspray reduction of Trichoptera followed a period of high drift, primarily of *Pycnopsyche* (Trichoptera) (Table 4). Mackay and Kalff (1973) reported that high drift of this organism typically occurs in early spring.

The drift samples for the control brooks show several trends: 1) an increasing Ephemeroptera drift from May to August 2) a decreasing Plecoptera drift during this time and 3) a relatively consistent number of taxa in the drift sample (Table 4).

### Orthene

Significant increases in taxa and numbers of organisms occurred from May to August in samples from Squapan Inlet (Table 2). These changes were attributed to increases in numbers of taxa of Trichoptera and Plecoptera and numbers of individual Plecoptera and Ephemeroptera (Table 3). Drift of Trichoptera and Diptera in this stream showed increases in total numbers of taxa and numbers of individuals from May to August (Table 4).

There was no indication of any disturbance of benthic populations caused by spraying.

### Sevin 4 Oil

Dead aquatic insects were visible in two of the three streams sprayed with Sevin 4 Oil. Dead individuals were observed the day after spraying in Unnamed Brook, including many *Acroneuria* (Plecoptera) and *Hesperophylax* (Trichoptera). Mortality also occurred in *Alloperla* and *Isogenus* (Plecoptera), *Antocha*, *Hexatoma*, *Tipula*, and *Chironomidae* (Diptera), *Cheumatopsyche* and *Molanna* (Trichoptera), and *Cambarus* (Crustacea:Decapoda). Mortality of some of the same insects was lower in Mosquito Brook Tributary and absent in Sawtelle Brook Tributary.

The numbers of taxa and of individuals decreased in the first postspray sample from Mosquito Brook Tributary (Table 2). The changes were attributed to decreases in number of individual Diptera and Ephemeroptera and in the number of taxa of Ephemeroptera (Table 3). Numbers of taxa and of individual Plecoptera decreased in the second postspray sample and remained low in the August sample (Table 3). Numbers of individual Ephemeroptera remained low in July, but recovered to prespray levels by August. Diptera showed fluctuations in the number of individuals throughout the summer, but remained constant in May and August (Table 3).

Samples from Unnamed Brook showed a decrease in number of taxa per square foot during the July collections, as compared with samples taken in May and June (Table 2). The changes were attributed to decreases in numbers of taxa of Plecoptera and Ephemeroptera (Table 3).

No significant changes in numbers of taxa or of individuals among benthic organisms occurred throughout the summer in Sawtelle Brook Tributary

**Table 4. Total number of drifting Trichoptera, Plecoptera, Diptera, and Ephemeroptera<sup>1</sup> collected in 24 hours and total number of taxa collected per sample on each brook.**

Location and Date	Trichoptera	Plecoptera	Diptera	Ephemeroptera	Total Taxa
<b>Controls</b>					
<i>Crystal Bk.</i>					
5/13	6	5	13	29	14
6/5	8	8	4	40	17
7/9	16	1	16	195	14
8/19	15	3	27	401	17
<i>Sargent Bk.</i>					
5/13	7	30	72	223	36
6/5	8	33	59	176	32
7/9	0	5	3	4	9
8/19	16	2	32	190	20
<i>Tracy Bk.</i>					
5/27	3	32	79	40	21
6/9	0	9	17	5	11
8/23	16	3	20	0	11
<i>Railroad Bk.</i>					
6/1	411	20	24	1	15
6/12	5	53	52	7	17
7/21	19	11	34	92	22
8/23	49	8	5	267	16
<b>Orthene</b>					
<i>Squapan Inlet</i>					
5/27	4	0	9	3	7
6/4	2	0	4	0	7
7/21	8	0	18	3	13
8/23	19	0	113	8	11
<b>Sevin 4 Oil</b>					
<i>Mosquito Br. Trib.</i>					
6/7	1	4	41	2	12
6/12	3	9	25	1	12
7/21	1	0	119	8	18
8/23	7	0	23	11	12
<i>Unnamed Brook</i>					
5/31	1	2	30	1	12
6/5	2(7) <sup>2</sup>	4(5)	1(3)	1(4)	13
7/9	50	3	0	3	8
8/19	1	0	13	1	9
<i>Sawtelle Br. Trib.</i>					
5/13	21	0	21	3	13
6/5	114(20)	275(70)	93(10)	181(50)	23
7/9	5	0	11	0	6
8/19	6	0	8	4	15

**CONTINUED**

**Table 4. CONTINUED**

Location and Date	Trichoptera	Plecoptera	Diptera	Ephemeroptera	Total Taxa
<i>Brown Bk.</i>					
6/4	11	22	30	4	13
6/6 <sup>3</sup>	12(2)	5(1)	2(5)	1(0)	9
6/7	24	13	24	0	11
<i>Burpee Bk. Trib.</i>					
6/4	3	0	28	0	7
6/7	3	9	15	0	6
7/12	10	0	14	11	14
8/23	3	0	57	18	11

<sup>1</sup>A list of genera for these orders is contained in Appendix

<sup>2</sup>Numbers of dead organisms in parentheses are estimated in percent.

<sup>3</sup>Day of spraying.

(Table 2). This brook showed a dramatic increase in numbers of drifting organisms (Table 4), many of them probably dead. Poor body condition served as an indication that the insect was dead at the time of collection.

*Neophylax*, *Limnephilus* and *Lepidostoma* (Trichoptera), *Nemoura* and *Leuctra* (Plecoptera), and *Hexagenia* and *Baetis* (Ephemeroptera) showed the highest percentage of poor-quality specimens in the drift. Mortality for the Chronomidae and Simuliidae (Diptera) was estimated to be lower. Although the dead organisms in Mosquito Brook Tributary and Unnamed Brook were of different genera than those found in the drift of Sawtelle Brook Tributary, Plecoptera and Trichoptera in all three brooks showed a consistently high mortality.

### Dylox

Benthic samples from Brown Brook showed an increase in the mean number of taxa present from May to August (Table 2). The change was attributed to increases in numbers of taxa of Ephemeroptera and Trichoptera (Table 3). The mean number of individuals or of taxa in bottom samples from Burpee Brook Tributary did not change from May to August (Table 2). Plecoptera drift in Burpee Brook Tributary occurred only on the day after spraying (Table 4).

### DISCUSSION

Little has been published on the effects of Orthene on stream invertebrates, as determined in field studies. The 1977 draft environmental impact statement (see bibliography) cites one report that found no increased drift after Orthene treatment. No effects of Orthene were detected in the present study. Control streams and Orthene-sprayed streams yielded similar benthic samples throughout the observation period.

A sustained reduction in numbers of Plecoptera and short-term reductions in numbers of Diptera and Ephemeroptera occurred in two of the three

streams sprayed with Sevin 4 Oil. Benthic samples from Sawtelle Brook Tributary did not show any response to spraying, but drift one day after spray increased dramatically. Burdick *et al.* (1960) reported increased drift and decreased bottom populations after streams had been sprayed with 1½ lb Sevin/acre.

No spray droplets were observed on foliage at the Sawtelle Brook Tributary sample site. Lack of changes in benthic samples and the dramatic increase of drift indicate that upper reaches of Sawtelle Brook Tributary may have been sprayed with Sevin 4 Oil, but the area sampled was not, probably because the sampling area was surrounded by old fields grown in with alder and pine, whereas upstream areas were stands of spruce and fir.

Two of the unsprayed brooks, Sargent and Railroad, show decreased benthic populations in the first postspray sample. Railroad Brook may have received spray contamination, since a deposit of Sevin 4 Oil was seen on foliage at the sample site. The only order in Railroad Brook in which standing crop changed was Trichoptera, and these changes were attributable to drift. The changes in numbers of taxa and of individual Trichoptera, Plecoptera, and Ephemeroptera in Sargent Brook were either temporary decreases or part of a fluctuation in standing crop throughout the summer, but no explanation could be found for these changes.

Dylox-treated streams showed population trends similar to those of the control streams. The drift of Plecoptera on the first postspray sample in Burpee Brook Tributary could have been caused by spray or an emergence of adults. Rabeni and Gibbs (1975) and Kingsbury (1976) had reported no significant effects of Dylox on aquatic organisms.

### CONCLUSIONS

Orthene and Dylox, applied to streams incidental to attempts at chemical control of spruce budworm, had no detectable effects on benthic populations of aquatic insects under the conditions of the tests. Quality of drift was not changed by these chemicals.

Application of Sevin 4 Oil significantly decreased the populations of Ephemeroptera, Diptera, and Plecoptera immediately after spraying and the reductions of Plecoptera persisted at least two months. Treatment may also have caused increased drift.

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#### APPENDIX

A list of Trichoptera, Plecoptera, Diptera and Ephemeroptera collected in the ten streams included in this study.

Family	Genus
Trichoptera	
Philopotamidae	Wormaldia
	Chimarra
Polycentropodidae	Cynellus
	Neureclipsis
	Nyctiophylax
	Polycentropus
	Phylocentropus
Hydropsychidae	Parapsyche
	Cheumatopsyche
	Hydropsyche
Rhyacophilidae	Rhyacophila
Glossosomatidae	Glossosoma
	Agapetus
Phryganeidae	Oligostomis
	Ptilostomis
Brachycentridae	Brachycentrus
Limnephilidae	Onocosmoecus
	Pycnopsyche
	Hesperophylax
	Limnephilus
	Psycoglypha
	Neophylax
	Geora
Lepidostomatidae	Lepidostoma
Odontoceridae	Psilotreta
Molannidae	Molanna
Leptoceridae	Caraclea
	Mystacides

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## APPENDIX CONTINUED

	Plecoptera
Pteronarcidae	Pteronarcys
Nemouridae	Nemoura
Leuctridae	Leuctra
Perlidae	Acroneuria
	Neoperla
	Phasganophora
Perlodidae	Isogenus
	Isoperla
Chloroperlidae	Alloperla
	Diptera
Tipulidae	Antocha
	Dicranota
	Hexatoma
	Pseudolimnophila
	Tipula
Blephariceridae	Blepharicera
Dixidae <sup>1</sup>	
Ceratopogonidae <sup>1</sup>	Atrichopogon
Chironomidae	
Simuliidae <sup>1</sup>	
Stratiomyiidae <sup>1</sup>	
Tabanidae	Chrysops
	Tabanus
Rhagionidae	Atherix
Empididae <sup>1</sup>	
	Ephemeroptera
Heptageniidae	Arthroplea
	Epeorus
	Heptagenia
	Rithrogena
	Stenonema
Baetidae	Baetis
Leptophlebiidae	Habrophlebia
	Paraleptophlebia
Ephemerellidae	Ephemerella
Caenidae	Caenis
Ephemeridae	Ephemera
	Hexagenia

<sup>1</sup>All members of the family not identified to genus.

### PESTICIDE STATEMENT

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for disposal of surplus pesticides and pesticide containers.





